Claims:

I claim:

1. A distributed diagnostic and prognostic system for monitoring the health status and integrity of conduits, the system comprising:

a plurality of local health status and integrity monitoring devices each capable of inspecting the health status of local individual conduits and conduit components, each local monitoring device having:

a centralized data processor coupled to the plurality of local monitoring devices, the centralized data processor for receiving from each local monitoring device the local data concerning its associated conduits, for generating a set of weighting parameters for each local conduit monitoring device, and for communicating the set of weighting parameters to each local conduit monitoring device; and

a local data processor of each local monitoring device further for receiving the set of weighting parameters, collecting data regarding the local conduit and analyzing the local data using the set of weighting parameters for local diagnostic and prognostic purposes.

2. An monitoring device for use in monitoring at least one conduit with at least one conductor for diagnostic purposes, the device comprising:

at least one programmed microcontroller or other processor for the purpose of acquiring the sensor information from a set of sensors and sensitized medium, conditioning and normalizing the sensor information based on parameters and environmental condition of the conduit, and for processing the normalized information to provide an output signal indicative of the diagnostic condition and the prognostic estimate of remaining useful life of the conduit and conductors it monitors.

a set of sensors having outputs coupled to the programmed processor, at least one sensor being an environmental sensor for providing environmental information indicative of the local environmental condition, and sensors that are strips or strands of heterogeneous sensitized medium said medium either essentially opaque to signal transmission, or selected from the group of mediums that are capable of supporting or conducting an electrical current and voltage, an electromagnetic signal, an optical signal, an audio signal, and an indicating substance with the purpose to provide sensor information

indicative of damage to the sensitized medium; with each sensor or strand of sensitized medium being positioned with respect to the conduit to provide information concerning the environment and damage and deterioration to the conduit; and

means operatively associated with the programmed processor for operating the processor in a birth certificate mode wherein the outputs of the sensors are processed by the programmed processor and stored in as baseline operational parameters; and

means associated with the programmed processor for operating the device in a monitoring mode, after the program has operated in the birth certificate mode, wherein the programmed processor acquires, conditions, and processes the outputs from the sensors, compares the processed outputs to the baseline operating parameters, and provides an indication of the diagnostic condition of the conduit based on the comparisons.

3. The device of claim 2 wherein the sensor set includes a strand that incorporates a mechanism as a means to mark location of damage such as but not limited to, fluorescent debris or a fluorescent dye.

4. The device of claim 2 wherein the sensor set includes at least one temperature sensor and the baseline operational parameters include the said temperature sensor: (i) means; (ii) variances; (iii) range; (iv) and the overall temperature spectrum characteristics of the conduit.

5. The device of claim 2 wherein the sensor set includes at least one vibration sensor and the baseline operational parameters include the said vibration sensor: (i) means; (ii) variances; (iii) range; (iv) and the overall vibration spectrum characteristics of the conduit.

6. The device of claim 2 wherein the sensor set includes at least one conduit electro-magnetic interference (EMI) sensor and the baseline operational parameters include the said EMI sensor: (i) means; (ii) variances; (iii) range; (iv) and the overall spectrum of EMI characteristics of the conduit.

7. The device of claim 2 wherein the sensor set includes at least one strand of temperature sensitized medium and the baseline operational parameters include the said strand of

temperature sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

8. The device of claim 2 wherein the sensor set includes at least one strand of corrosivity sensitized medium and the baseline operational parameters include the said strand of corrosivity sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall spectrum of corrosivity characteristics of the strand.

9. The device of claim 2 wherein the sensor set includes at least one strand of chafing sensitized medium and the baseline operational parameters include the said strand of chafing sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

10. The device of claim 2 wherein the sensor set includes at least one strand of pressure sensitized medium and the baseline operational parameters include the said strand of pressure sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

11. The device of claim 2 wherein the sensor set includes at least one strand of chemically sensitized medium and the baseline operational parameters include the said strand of chemically sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

12. The device of claim 2 wherein the sensor set includes at least one strand of piezoelectric sensitized medium and the baseline operational parameters include the said strand of piezoelectric sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

13. The device of claim 2 wherein the sensor set includes at least one strand of base metal coated medium and the baseline operational parameters include the said strand of base metal coated medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

14. The device of claim 2 wherein the sensor set includes at least one strand of noble metal coated medium and the baseline operational parameters include the said strand of noble metal coated medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

15. The device of claim 2 wherein the sensor set includes at least one strand of clad silica sensitized medium and the baseline operational parameters include the said strand of clad silica medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

16. The device of claim 2 wherein the sensor set includes at least one strand of fluorescent doped sensitized medium and the baseline operational parameters include the said strand of fluorescent doped sensitized medium: (i) means; (ii) variances; (iii) range; (iv) and the overall characteristics of the strand.

17. The apparatus of claim 2 further comprising a communication link, and a communication control circuit coupled to the programmed processor and to the communication link, the communication control circuit being adapted to communicate information and data over the communication link.

18. The apparatus of claim 2 further comprising a visual indicator coupled to the processor for receiving the output signal generated by the processor, and for providing a visual indication of the diagnostic condition of the conduit based on the output signal.

19. The sensitized media of claim 2 providing a means for coupling to a plurality of conductors and connectors at spaced apart locations along the branches; and
    a terminator connected to a first connector; and,
    a means to attach appropriate signals including, but not limited to, direct current or alternating current electricity, radio waves, audio signals, and beams of light; and
    a means to attach a signal analysis instrument.

20. The sensitized media of claim 2 in which the signal generators with the signal detectors and the microcontroller of claim 3 comprise a means to quantitatively measure changes in signals and secondary effects as a means to detect the presence, degree, and location of deterioration or damage to the insulation material.

21. The sensitized media of claim 2 made up of diverse sensitized media including hollow, filled or solid strands, fibers and strips made with combinations of inorganic, organic or man-made materials.

22. The sensitized media of claim 2 in which the insulation material comprises a mixture of dielectrics.

23. The sensitized media of claim 2 in coaxial relationship to the insulated cores with linear, curvilinear, or helical format.

24. The sensitized media of claim 2 fabricated on an inner layer of the insulation.

25. The sensitized media of claim 2 fabricated on the outer surface of the insulation.

26. The sensitized media of claim 2 that conduct electricity.

27. The sensitized media of claim 2 that conduct light

28. The sensitized media of claim 2 that conduct electromagnetic waves.

29. The sensitized media of claim 2 that conduct acoustic waves.

30. The sensitized media of claim 2 that act as waveguides.

31. The sensitized media of claim 2 that act as transmission lines.

32. The sensitized media of claim 2 when joined by a multiplicity of connectors to create a plurality of sections.

33. The conduit of claim 2 comprised of one or more non-insulated conducting strands.

34. The conduit of claim 2 comprised of one or more insulated conducting strands.

35. The conduit of claim 2 when joined by a multiplicity of couplings to create a plurality of sections.

36. The conduit of claim 2 the material whereof is comprised of a liquid.

37. The conduit of claim 2 the material whereof is comprised of ceramic.

38. The conduit of claim 2 the material whereof is comprised of metal.

39. The conduit of claim 2 the material whereof is comprised of plastic

40. The conduit of claim 2 the material whereof is comprised of glass

41. The conduit of claim 2 the material whereof is comprised of a concretion.

42. A method for diagnosing and prognosing the health status of conduits, the method comprising the steps of:

determining the requirements for monitoring the system of conduits;

defining the functions of the distributed computers, diagnostic and prognostic software to meet the requirements;

selecting the parameters to be sensed and monitored;

selecting the components consisting of electronics, hardware, software, firmware and set of discrete sensors and strips of sensitized medium to implement the functions;

designing and manufacturing the form and fit of the monitoring device comprised of said components;

applying, placing, attaching or embedding the monitoring apparatus and sensors consisting of at least one strand of said sensitized medium along the length of said conduit, wherein said strands of sensitized medium has a first end and a second end, said strands of sensitized medium being placed such that damage inducing factors such as an a solid object, gas, liquid, powder or electromagnetic waves contacts said medium prior to contacting said conduit;

determining by a combination of measurement by signal processing and deductive algorithms whether, when and where and to what extent said damage inducing factors have damaged each of said multiplicity of sensitized medium;

comprising the steps of:

I. using said apparatus to periodically monitor at least a portion of the system of conduits at given points in time over a first extended period and, for each point in time, storing in a digital memory a data couplet containing information concerning the parameters, and the point in time;

using digital processors to identify couplets having normal values within a predetermined range; and

providing an indication of steady state characteristics if the readings for at least a predetermined number of couples are within a first predetermined range; and

providing a programmed diagnostic algorithm for assessing risk of damage and extent of deterioration and damage to the monitored conduits; and

providing a prognostic algorithm for estimating the remaining useful life of the monitored conduits and components; and

providing a protocol for communicating the information about sensed damage, deterioration, as well as diagnostic and prognostic information concerning the health status and integrity of the monitored conduits; and

II. performing a first test sequence on each of the multiplicity of sensitized medium for the purpose of forming a baseline of characteristic parameters of each said medium for future reference by measuring the characteristics and storing the characteristics in accessible storage medium or location for future use.

III. from time to time performing the same said test sequence on each of the multiplicity sensitized medium;

determining if said measured characteristics are substantially equal to previously measured characteristics, the possible outcomes being:

a. there is no measurable change to the sensitized portion of the medium
b. there is measurable change to the sensitized portion of the medium;
c. the medium is disrupted, i.e. broken, eroded, cut through or dissolved;

choosing whether to repeat said step of measuring and said step of determining at another point of said medium;

if the choice is to repeat, then repeating said steps of measuring and determining;

IV. with the processor, using a deductive algorithm along with any a priori probability information:

a. process data from said measuring of said multiplicity of sensitized medium into characteristic information; and
b. determine any change of said characteristics from baseline characteristics; and
c. record the information for later use; and
d. choosing whether to measure the position of the change;

if the choice is to measure then measure the location of the change using either direct calculation based on the response to the applied signal; or apply a measuring technique such as reflectometry on a waveform conducting medium; and
record the measured value and temporal information if available; and
using a calculus estimate the degree of damage for each said sensitized media at each recorded point of damage, for each time if temporal information is recorded.